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HEAT GENERATION OF BAGGED 'ASTRACEM'

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HEAT GENERATION OF BAGGED 'ASTRACEM'

by

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ABSTRACT

The heat generated by a bag of 'Astracem' powder left on the damp floor of the 10E coal road at Lingan Colliery provoked concern from colliery workmen about the possibility of the heat causing an underground fire.

At the request of Lingan Colliery management, the CANMET Cape Breton Coal Research Laboratory (CBCRL) in Sydney agreed to investigate the problem. The results of the investigation, which showed that there was no danger from the heat generated by the hydrating cement, are given in this report.

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PRODUCTION DE CHALEUR PAR DE L'"ASTRACEM" EN SAC

par

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RÉSUMÉ

La chaleur dégagée d'un sac contenant de la poudre "ASTRACEM" placé sur un plancher humide de la voie 10E de la houillère Langan a provoqué chez les travailleurs de la mine une certaine inquiétude quant aux risques d'incendies souterrains qui pourraient être engendrés par cette chaleur.

Par conséquent, à la demande de la Gestion de la houillère Langan, le Laboratoire de recherche sur le charbon du Cap-Breton à Sydney a accepté d'examiner le problème. Les résultats de l'examen ont démontré qu'il n'y avait aucun danger d'incendie causé par la chaleur produite par le ciment hydraté. Enfin, les résultats de l'examen sont aussi présentés dans ce rapport.

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INTRODUCTION

The 10E coal road at Langan Colliery employs an 'Astrapack' monolithic pump packing system. The packs are prepared from two bagged powders transported into the face end and mixed to form two grouts which are then pumped into the prepared pack area. One of the powders, 'Astracem', is a specially blended quick setting cement containing a high proportion of high alumina cement (HAC).

Although it is generally known that cements, especially those containing HAC, generate heat during the hydration process, workmen in the 10E coal road were concerned to find a bag of 'Astracem' apparently smoking and too hot to handle. The bag had been dropped in the roadway where it had absorbed some moisture and had begun to hydrate. Concern was raised that the heat generated might be sufficient to cause combustion of wood, paper or coal lying adjacent to the bag in the gateroad.

Colliery management asked the Cape Breton Coal Research Laboratory (CBCRL) to investigate the complaint and to determine whether or not there was a fire hazard. Four bags of 'Astracem' were tested as described below.

INVESTIGATION METHOD

Four bags of 'Astracem' were obtained from the colliery stockyard. Each was tested as follows:

- 1) One side of the bag was thoroughly perforated to allow water to seep in.
- 2) The bag was placed in a tray containing water to a depth of 4 cm.
- 3) Holes were punctured at each corner of the top surface of the bag, with another hole in the middle.
- 4) High pressure water was introduced into the holes on the top surface of the bag to thoroughly wet the contents.
- 5) The cement bag was completely covered by bags of stonedust, acting as an insulating layer.

The temperature generated by the cement was monitored in the first three tests by a mercury thermometer placed in the central hole in the cement bag. In the final test, a thermocouple was placed between the cement bag and the insulating stonedust bags and connected to a chart recorder to obtain a continuous record of the temperature changes.

RESULTS

The results obtained from the first three tests are given in Table 1 and described below:

Test 1: was initiated at 12:15 p.m. and showed a slow temperature rise to 20°C until readings stopped for the day at 17:15 after 300 minutes. The next readings were taken from 8:15 the following morning (900 minutes) and showed a decrease in temperature from 42°C to 36°C after 1140 minutes. The peak temperature had occurred overnight.

Test 2: was started at midnight to allow eight hours before the second reading and hopefully monitor the temperature peak during working hours. Unfortunately, when readings resumed at 7:45 a.m. after 465 minutes, the temperature was 98°C. This rose to 99°C after a further 30 minutes, then dropped steadily to 77°C after 680 minutes.

Test 3: began at 11:25 a.m. with an increased frequency of readings. After 285 minutes the temperature was 35.5°C, a climb of 9.5°C. Twenty minutes later the temperature was 102°C and falling, declining to 32°C after 625 minutes.

These test results indicated that the cement hydration produced a rapid temperature rise, the timing of which appeared to be variable. For the fourth test, a thermocouple connected to a chart recorder was used to obtain a continuous record of the temperature gain (Figure 1). In this test, the temperature rose steadily until 412 minutes, when a rapid increase to 102°C

occurred in less than 6 minutes. After this the temperature dropped steadily to 87°C after 510 minutes at which point the test was stopped.

Table 1 - Temperature generation with time for soaked 'Astracem' bags

Time (minutes after start of test)	Temperature (°C)		
	Test		
	1	2	3
0	23	23	26
30			27.5
80			31
140			33
170			33
180	26		
250			33.5
280			34.5
285			35.5
300	29		
305			102
335			101
355			99
465		98	
490			78
495		99	
525		96	
540		94	
545			32.5
570		90	
610		86.5	
625			32
680		77	
900	42		
1020	39		
1140	36.6		

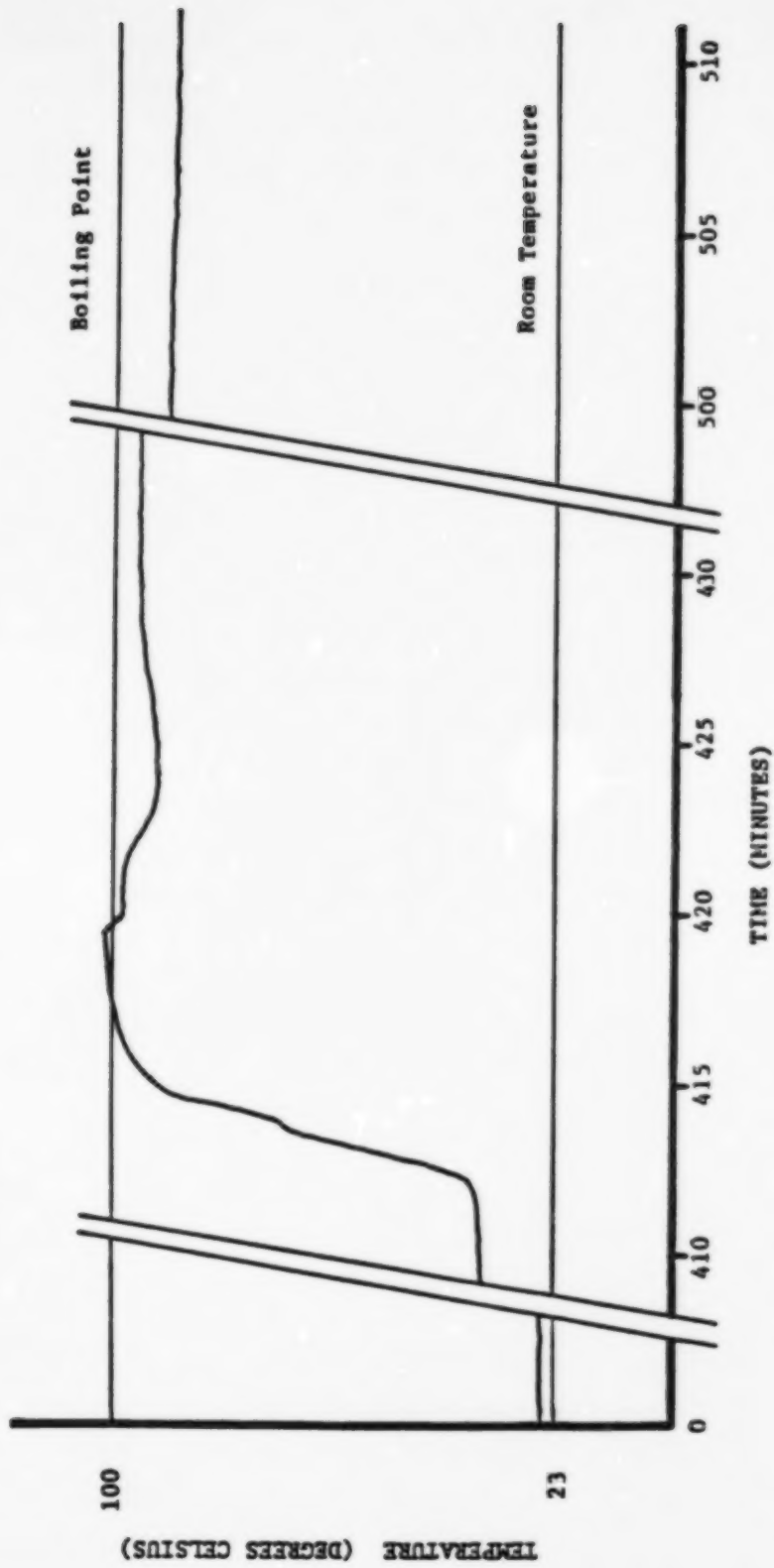


Figure 1 - Temperature vs time for test Number 4

DISCUSSION

The variation in time interval between the start of the tests and the rapidity of the temperature rise associated with hydration prevented accurate monitoring of the first three tests. In the final test, however, a full and accurate record was obtained, and the results can be considered representative of the hydration of bags of 'Astracem' in the 10E coal road. The maximum temperature observed was 102°C, which was maintained for 30 minutes in Test 3, but only 2 minutes in Test 4.

In theory, a temperature of 100°C is the maximum that can be obtained for the following reasons:

- 1) Hydration will not occur unless water is present.
- 2) If the heat of hydration developed is sufficient to boil the water, the temperature must remain at 100°C until all the water is boiled off (an analogy is a saucepan in which an egg is being boiled - the egg will not burn until all the water has boiled away).
- 3) When all the water has boiled off, hydration must stop. This will bring about cooling as it the chemical reaction associated with hydration that generates the heat.

The temperatures of 102°C recorded in the tests were probably due to the superheating of pockets of steam under pressure from the overlying stonedust in the cement bag. Although a pressure of only 4 psi will increase the boiling point of water to 106°C, it is very unlikely that this pressure could be maintained for long under the conditions prevailing in the gateroad, and it is therefore unlikely that the temperature in the cement bag will rise above it.

The major concern of the workmen at Lingan Colliery was the possibility that the hot 'Astracem' bags could cause a fire by igniting the paper sacks or the coal, oil or wood present in the gateroad.

The lowest quoted ignition temperature for coal is 180°C for a dry layer of coal dust. The corresponding temperature for lubricating oil is approximately 135°C or above (NFPA 1976). Paper and wood have a more complex ignition process which depends largely on the temperature and the length of

time it is applied. Ignition will not occur below 280°C, at which time the wood or paper must be dry (NFPA 1976).

Wood in contact with temperatures in excess of 100°C for long periods of time (weeks or months) may dry out completely and undergo a chemical change resulting in the formation of charcoal which may ignite spontaneously. The results of the tests described above, the ignition properties of wood, paper and coal were discussed with Mr. Gordon Smith, Deputy Fire Marshall of the Province of Nova Scotia. He expressed the opinion that the heating of isolated bags of 'Astracem' underground represents no danger of fire because of the short duration of the temperature peak and the damp conditions.

CONCLUSIONS

The test results and subsequent analysis confirm that there is no danger of fire presented by the heating of isolated bags of 'Astracem' because the maximum achievable temperature and the short time over which it acts is too low to cause a chemical change in any of the flammable materials available in the gateroad.

The discomfort associated with handling the hot bags of hydrating cement can be overcome by breaking up the bags and disposing of them in the waste with a shovel.

Ultimately, the phenomenon of excess heat generated by the hydration of bags of 'Astracem' powder can only be prevented by the maintenance of correct handling and storage procedures.

REFERENCES

1. National Fire Prevention Association, "Fire protection handbook"; 14th Edition; NFPA; Boston, Mass; 1976.